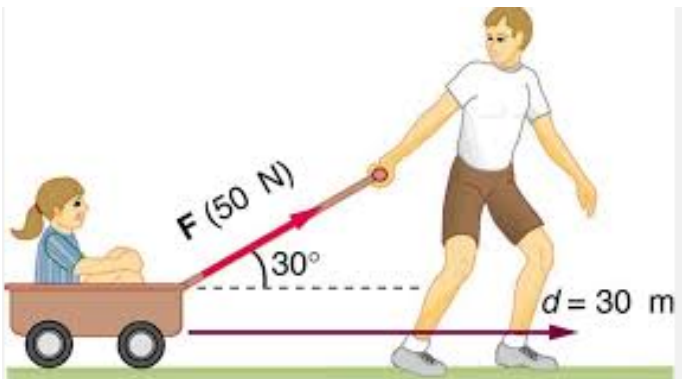


# VECTORS – LAB – Name \_\_\_\_\_ prepared by Dr. V. Lankar

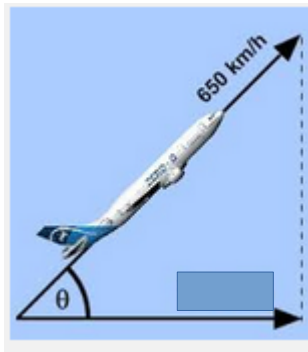
A vector represents a physical quantity that has both magnitude and direction  
The vector shows: how much, of what, which way

Examples of physical quantities that are vectors:

**Force.** You are pulling a cart with a force of **50 newtons @ 30 degrees**.  
50 newtons is about 10 pounds

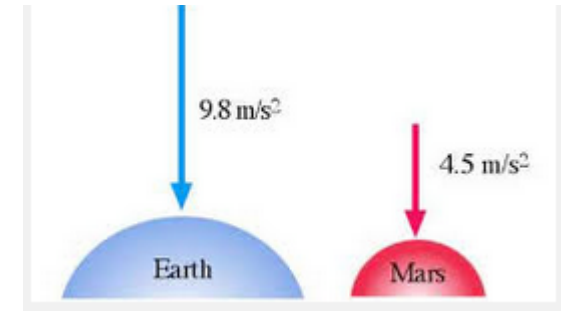


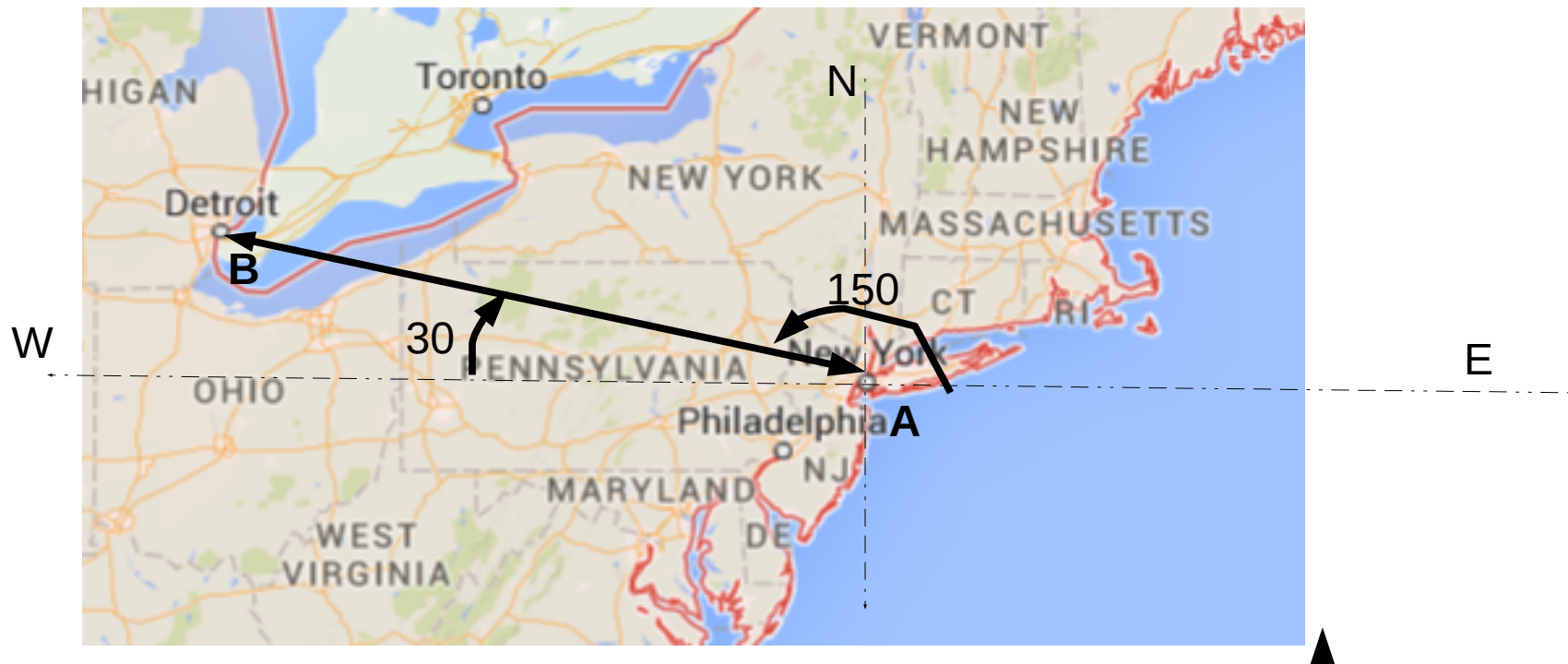
**displacement.** While pulling you move the car **30 meters @ right**.  
30M@ right is a vector displacement.



**velocity.** The airplane is taking off with a velocity of  $650 \text{ km/s} @ 45$   
Its speed is  $650 \text{ km/s}$  and its direction is 45 degrees (theta).  
Velocity is a vector =  **$650 \text{ km/s} @ 45$**   
Speed is a scalar. It has no direction.

**acceleration.** If an object speeds up, slows down or change direction there  
Is a change in its velocity. The rate of change is the acceleration.  
An object in free-fall has an acceleration =  **$22 \text{ mph/s} @ \text{down}$**  no Earth  
So every second, it goes  $22 \text{ mph/s}$  faster.  
Or acceleration =  $9.8 \text{ m/s/s} @ \text{down}$ .  $9.8 \text{ m/s} = 22 \text{ mph}$



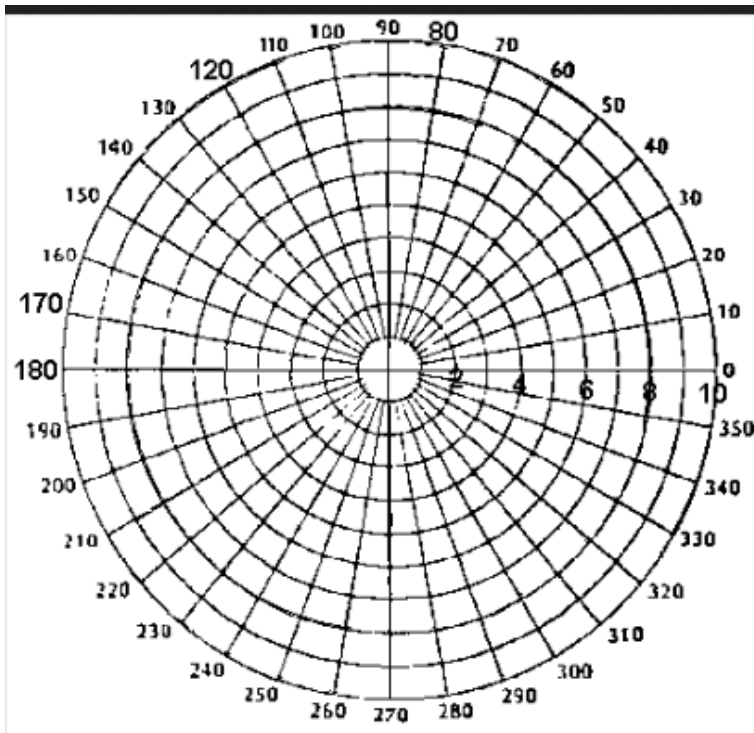


AB is a vector displacement  
 A is the head and B the tail.  
 The magnitude is 600 miles  
 The direction is 30 degrees N of W

Notations:

600 miles@30 N of W  
 600 miles @ 150





Unit circle – the radius is one -  
 The direction is counterclockwise (ccw)  
 Angles are measured in degrees or radians  
 $180 \text{ degrees} = 1 \pi \text{ radians} = (3.14 \dots \text{radians})$

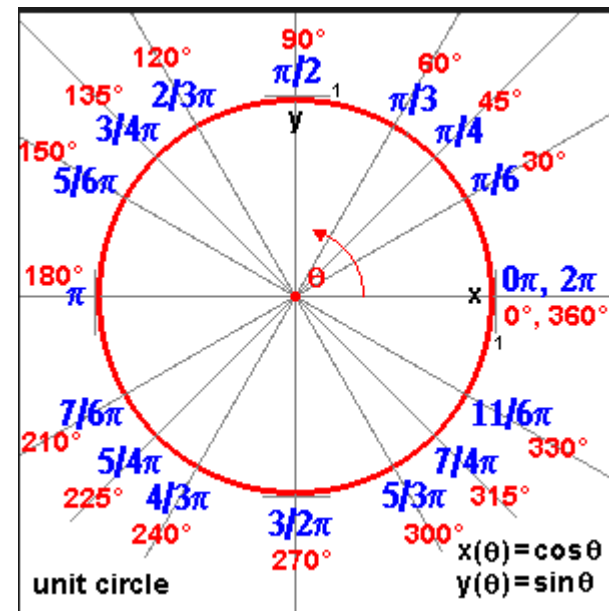
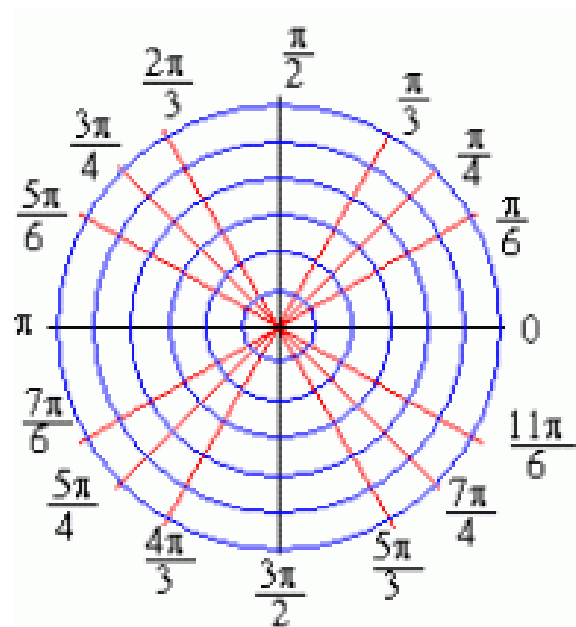
Examples:

54 degrees in radians ?  $= 54 \times \pi / 180$

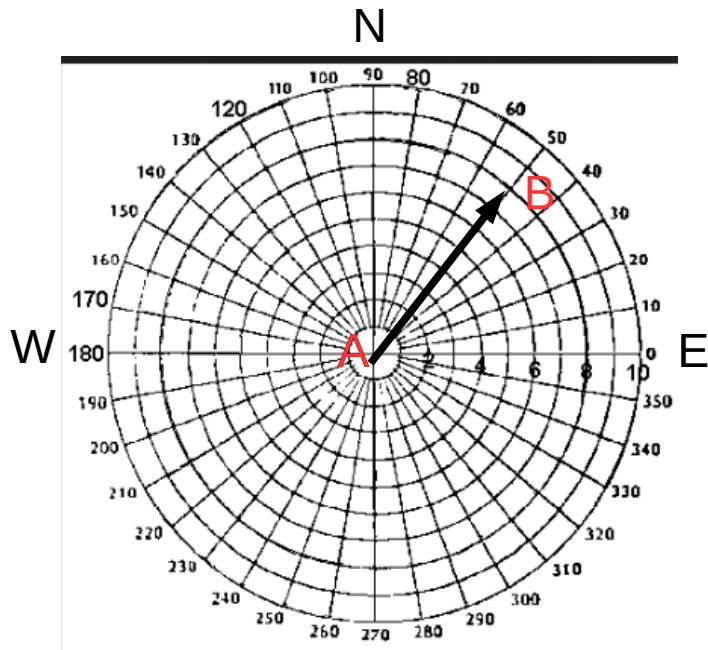
6 radians in degrees ?  $= 6 \times 180 / \pi$

$\pi/3$  in degrees ?  $= 180/3 = 60 \text{ degrees}$

$\pi$  is 3.14159...



## Polar notation for vectors:

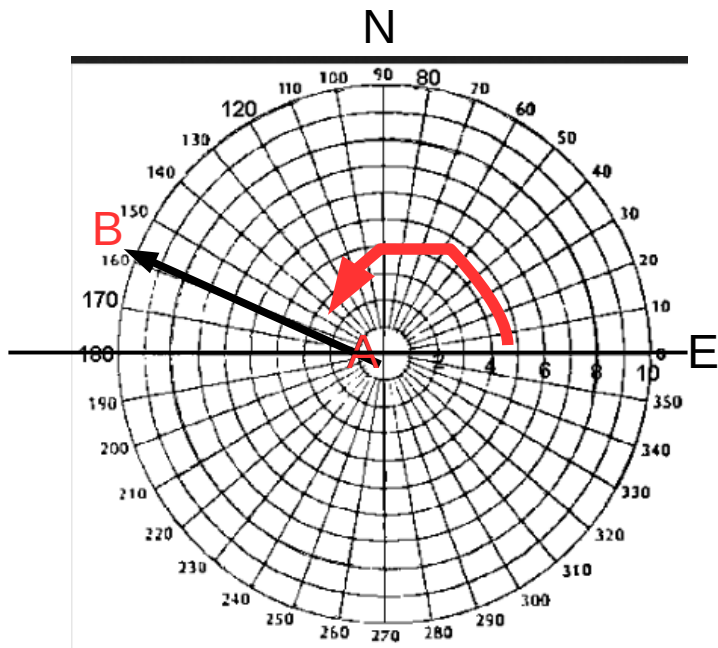


We can use several notations. Let's call this vector AB. AB is a vector displacement. A object could have been moved from A to B by a distance of 8 feet in the direction Shown. Here are the notations :

**AB = 8 feet @ 50 N of E** or

In standard notation (used in Physics) **just AB = 8ft @ 50**  
Also called the polar notation.

A vector has a magnitude (8ft) and a direction (50).  
It shows how much (8) , of what (ft), which way (50).



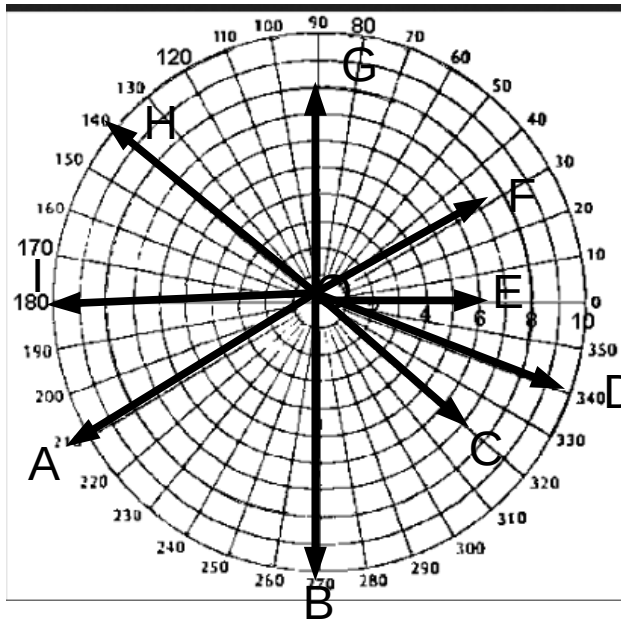
**AB = 10 ft @ 160** in standard notation or

**AB = 10ft @ 20 N of W**

We don't write 70 W of N because we want an angle smaller than 45

Magnitude is 10 feet.

**So in standard notation the angle is always between 0 and 360.**  
We always go counter clockwise



Use 2 notations for each of those vectors:

### Standard notation (Physics)

OD = 10 ft @ 340

OA=

OB=

OC=

OE=

OF=

OI=

### orientation notation

OD= 10ft@ 20 S of E or OD= 10ft @ -20

OA=

OB=

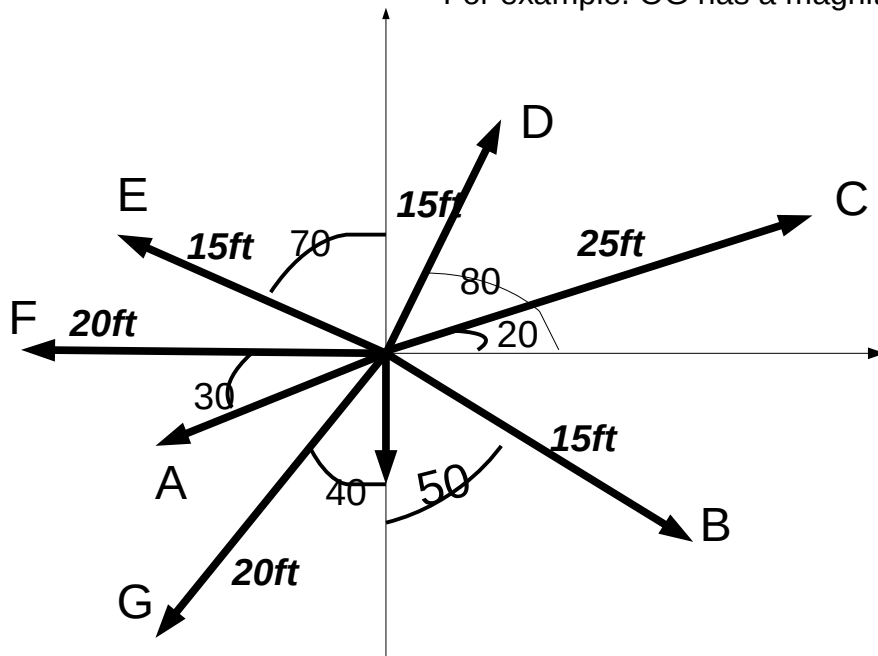
OC=

OE=

OF=

OI=

Now you should be able to do the same thing without the trigonometric circle.  
For example. OG has a magnitude of 20 ft.



OG = 20ft @ 40 S of W or OG = 20ft @ 230

OA=

OB=

OC=

OD=

OE=

OF=

OG=

or OA=

or OB=

or OC=

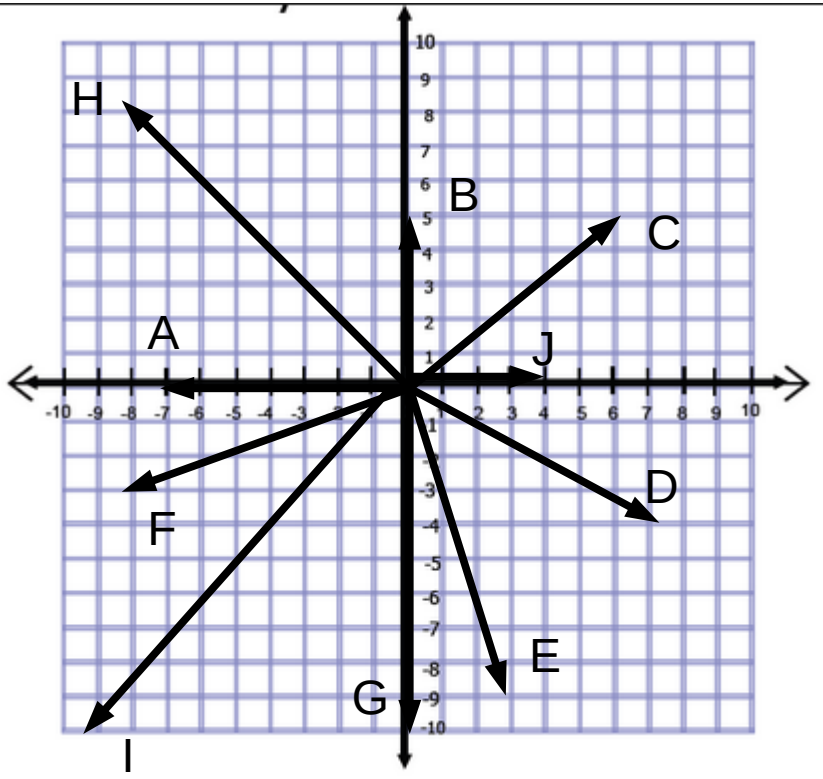
or OD=

or OE =

or OF =

or OG =

Vectors can also be described by their components instead by their magnitude and direction.



OD has components (7,-4) We write OD(7,-4)

OA ( , )

OH ( , )

OB ( , )

OI( , )

OC ( , )

OJ ( , )

OE ( , )

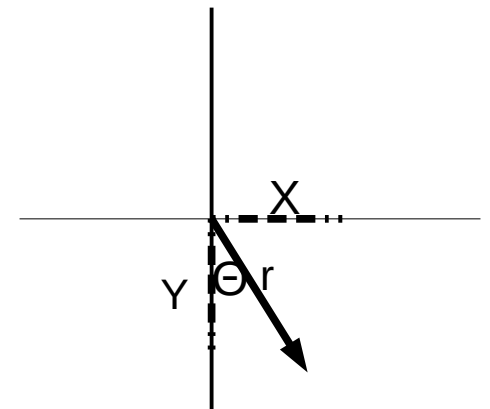
OG ( , )

If you have the components then you can find the magnitude using Pythagorean theorem and tangent. You are going from the component notation to the polar notation. The tricky part is to identify first the angle you are solving for. The magnitude is easy.

$$r = \sqrt{x^2 + y^2}$$

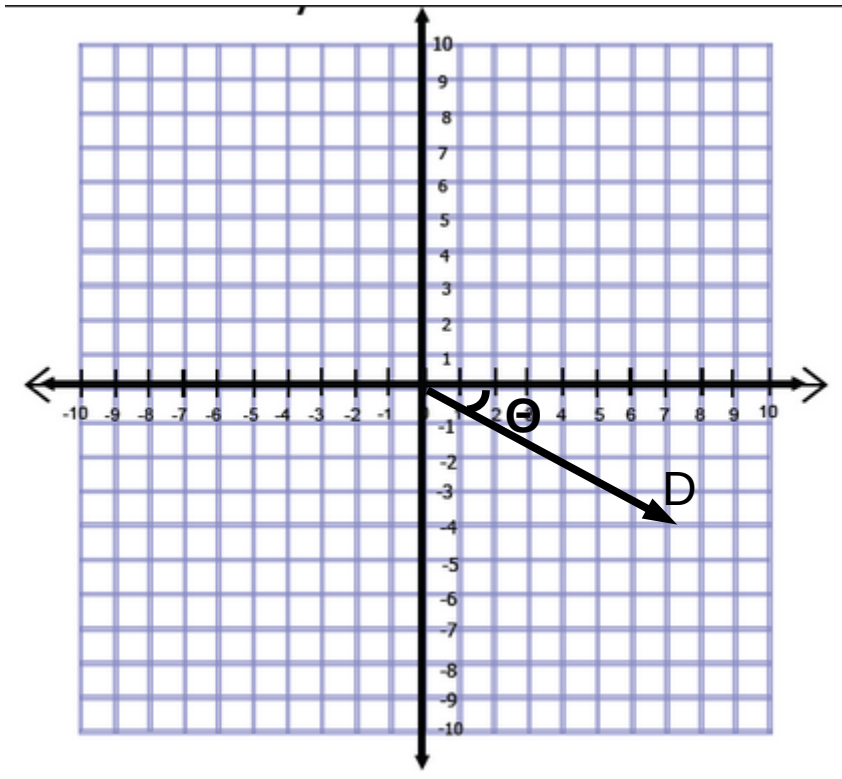
$$\tan(\Theta) = X/Y$$

$\Theta$  is smaller than 45





## Going from component notation to polar notation



For example OD has components (7,-4)

So  $x=7$  and  $y = -4$

1) First write on the graph the angle  $\Theta$  you are working with. You have 2 angles to work with.

The angle between the vector and the x-axis or  
The angle between the vector and the y-axis.  
I picked the x-axis because it is the smallest.

2) then use Pythagorean theorem to find **OD** the Magnitude (length). Ignore negative signs.

$$\mathbf{OD} = \sqrt{4^2 + 7^2} = \sqrt{65} = 8.1 \text{ ft}$$

3) find the angle (look at the graph ) using

**$\tan(\Theta) = \text{opposite} / \text{adjacent}$ . Ignore negative sign.**

$\tan(\Theta) = 4/7$  . You are not always using  $y/x$

It depends where  $\Theta$  is.  $Y/x$  works for the angle with x-axis

Use  $\tan(\Theta) = \text{opposite}/\text{adjacent}$ .

Solve for  $\Theta = 30$  about (29.7 degrees)

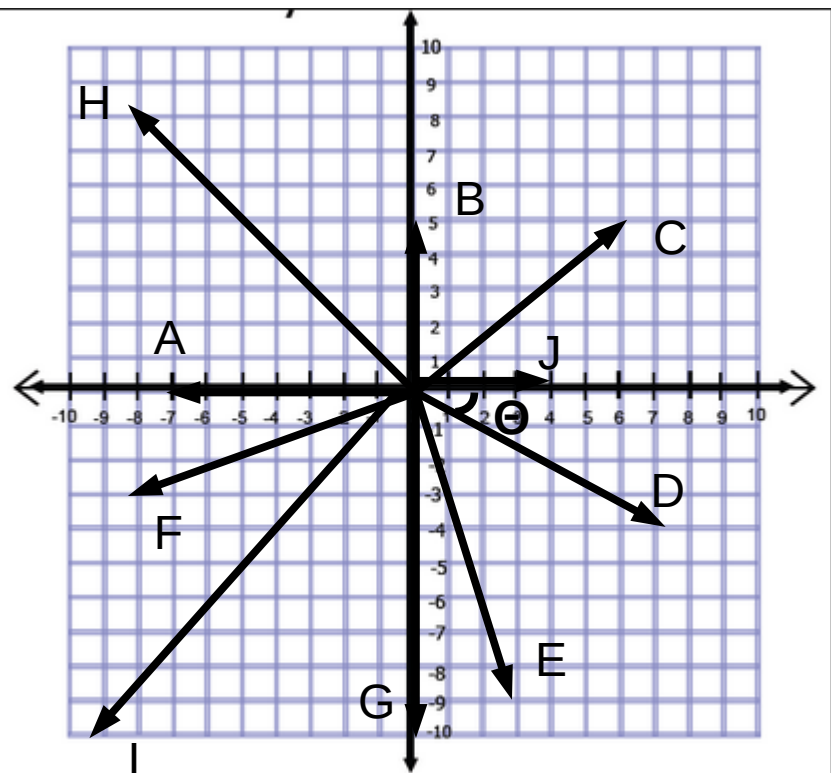
Make sure the mode is in degrees and not Radians.

4) write the notation **OD=8ft @ 30 S of E**

Or **OD= 8 ft @ 330** or **OD = 8ft @ -30**

You can use a negative angle only if the vectors is in the last quadrant.

## Going from component notation to polar notation



Convert the components notation to polar coordinates  
See previous page.

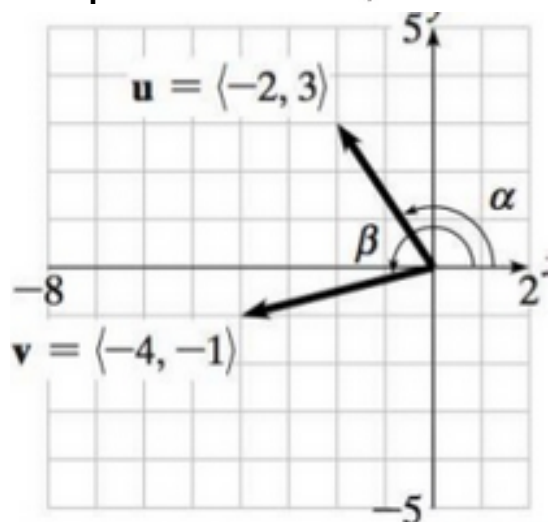
$$OA(-7, 0) =$$

$$OG(0, -10) =$$

$$OB( \quad , \quad ) =$$

$$OH( \quad , \quad ) =$$

$$OC( \quad , \quad ) =$$



$$U(-2, 3) =$$

$$V( \quad , \quad ) =$$

$$OE( \quad , \quad ) =$$

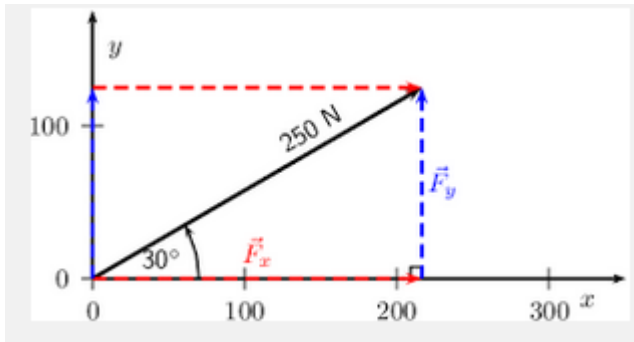
$$OI( \quad , \quad ) =$$

$$OF( \quad , \quad ) =$$

$$OJ( \quad , \quad ) =$$



## Going from polar notation to component notation



If a force of 250N is applied in a direction of 30 degrees N of E  
Then force  **$F = 250\text{N} @ 30$**

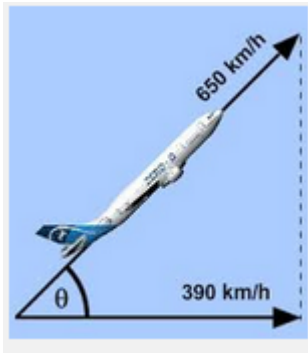
You can find the component  $F_x$  and  $F_y$ .

$F_x$  is how much the object was pulled along the x-axis

And  $F_y$  how much the object was pulled along the y-axis

$F_x = 250 \cos(30) = 216.5\text{N}$  and  $F_y = 125\text{N}$

So  $F = 250\text{N} @ 30$  and  $F (216.5, 125)$



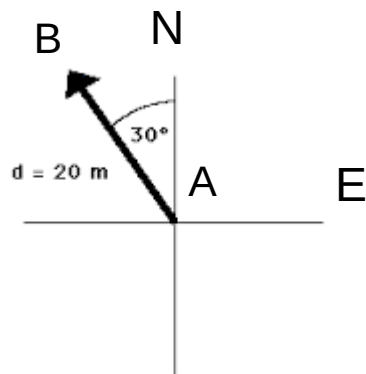
The airplane has a velocity of 650mph and takes off at an angle of 40 degrees.

**$V = 650\text{mph} @ 40$** . How fast is it going @ west (horizontally) ? (find  $V_x$ )

How is it going upward ? (find  $V_y$ )

$V_x =$

$V_y =$



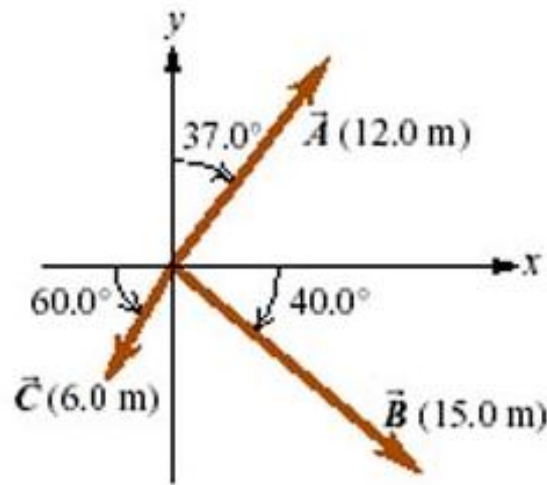
You are moving from A to B.  **$AB = 20 \text{ meters} @ 30 \text{ W of N}$**

How far did you move in the west direction ? (X-component  $< 0$ )

How far did you move in the East direction ? (Y-component)

$AB_x =$

$AB_y =$



Use cosine and sine to find the components of A, B, C  
 !! pay attention to the sign of the component. Make sure that a vector  
 Pointing left or down has a negative sign in front.

$$A_x = 12 \sin(37) = \dots$$

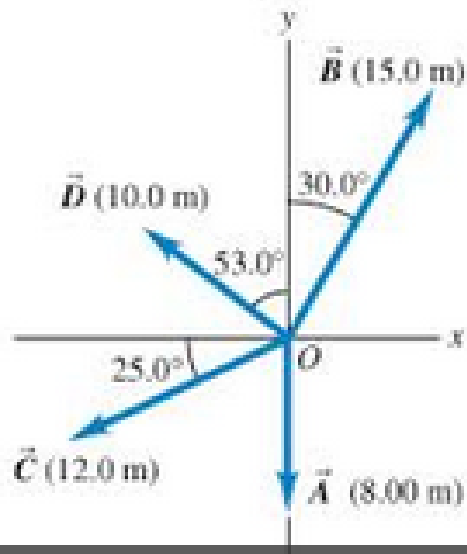
$$A_y = 12 \cos(37) =$$

$$B_x =$$

$$B_y = -$$

$$C_x = - \dots$$

$$C_y = - \dots$$



Make sure that a vector pointing left or down has a negative sign in front.

$$A_x =$$

$$A_y =$$

$$B_x =$$

$$B_y =$$

$$C_x =$$

$$C_y =$$

$$D_x =$$

$$D_y =$$